Global impact of Biotech crops: economic & environmental effects in the first ten years of commercial use

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Coverage

- Presenting findings of full report available from ISAAA on www.isaaa.org & www.pgeconomics.co.uk
- Version in peer reviewed journal: AgbioForum (Jan 2007) www.agbioforum.org
- Cumulative impact: 1996-2005
- Farm income impact: focuses on farm income
- Environmental impact analysis covering pesticide spray changes & associated environmental impact
- Environmental impact analysis: greenhouse gas emissions

Methodology

- Literature review of economic impact in each country – collates & extrapolates existing work
- Uses current prices, exch rates and yields (for each year): gives dynamic element to analysis
- Review of pesticide usage (volumes used) or typical GM versus conventional treatments
- Use of Environmental Impact Quotient (EIQ) indicator
- Review of literature on carbon impacts – fuel changes and soil carbon

Methodology: EIQs

- From Kovach et al (1992)
- Integrates various env impacts of indiv pesticides into a single field value/ha – allows for comparisons between products
- Is consistent and fairly comprehensive
- Compares level of use on GM with conventional crop usage to deliver equal level of efficacy

Key Findings

Pesticide Reduction

224 million kg

reduction in pesticides & 15% cut in associated env impact

Carbon Emissions

2005 = cut of 9 billion kg co2 release; equiv to taking 4 million cars off the road

Global Farm Income

$27 billion increase

After 10 years of commercialization, biotech crops have yielded a net increase in farm income while significantly reducing environmental impact.

Farm level economic impact

- 2005: farm income benefit $5.6 billion
- 2005: equiv to adding value to global production of these crops of 3.6% to 4.0%
- 55% of farm income gain in 2005 to farmers in developing countries
- Since 1996, farm income gain = $27 billion

Farm income effect: million $

Trait	Increase in farm income 2005	Increase in farm income 1996-2005	Farm income benefit in 2005 as % of total value of production of these crops in GM adopting countries	Farm income benefit in 2005 as % of total value of global production of these crops
GM HT soybeans	2,281 (2,842)	11,686 (14,417)	5.72 (7.1)	4.86 (7.1)
GM HT maize	212	795	0.82	0.39
GM HT cotton	168	927	1.16	0.64
GM HT canola	195	893	9.45	1.86
GM IR maize	416	2,367	1.57	0.77
GM IR cotton	1,732	7,510	12.1	6.68
Others	25	66	N/a	N/a
Totals	**5,027 (5,588)**	**24,244 (26,975)**	**6.0 (6.7)**	**3.6 (4.0)**

Notes: Bracketed figures include second crop benefits in Argentina

Farm income gains: by country: 1996-2005 million $

Since 1996, biotech crops have increased farm income $27 billion.

Other farm level benefits

GM HT crops	GM IR crops
Increased management flexibility/convenience	Production risk management tool
Facilitation of no till practices	Energy cost savings
Cleaner crops = lower harvest cost & quality premia	Machinery use savings
Less damage in follow on crops	Convenience benefit
	Improved crop quality
	Improved health & safety for farmers/workers

Impact on pesticide use

- Significant reduction in global environmental impact of production agriculture
- Since 1996 use of pesticides down by 224 m kg (-6.9%) & associated environmental impact -15.3%
- In 2005, reduction in volume of use is equivalent to 40% of total ai use in EU arable crop production

Impact on pesticide use

- Largest gains in soy sector: -51m kg (-4.1%) since 1996 & 20% decrease in environmental impact
- Major gains with GM IR cotton: - 94 m kg insecticide (-19%) & 24% reduction in env impact
- Important gains in corn sector: 4% & 4.6% respective reduction in env impact for HT & IR traits
- Greatest gains in US, Canada, Argentina & China

Changes in the use of herbicides & insecticides from growing GM crops globally 1996-2005

Trait	Change in volume of active ingredient used (million kg)	Change in field EIQ 'foot print' (in terms of million field EIQ/ha units)	% change in ai use in GM growing countries	% change in environmental 'foot print' in GM growing countries
GM HT soybeans	-51.4	-4,865	-4.1	-20.0
GM HT maize	-36.5	-845	-3.4	-4.0
GM HT cotton	-28.6	-1,166	-15.1	-22.7
GM HT canola	-6.3	-310	-11.1	-22.6
GM IR maize	-7.0	-403	-4.1	-4.6
GM IR cotton	-94.5	-4,670	-19.4	-24.3
Totals	**-224.3**	**-12,259**	**-6.9**	**-15.3**

Impact on greenhouse gas emissions

Lower GHG emissions: 2 main sources:

- Reduced fuel use (less spraying & soil cultivation)
- GM HT crops facilitate no till systems = less soil preparation = additional soil carbon sequestration

Reduced GHG emissions: 2005

- Reduced fuel use (less spraying & tillage) = 962 million kg less carbon dioxide
- Facilitation of no/low till systems = 8,053 m tonnes of carbon dioxide not released into atmosphere

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Equivalent to removing 4 million cars — 17% of cars registered in the United Kingdom — from the road for one year

Reduced GHG emissions: 1996-2005

- less fuel use = 2 m cars off the road (9% UK cars)
- additional soil carbon sequestration – not possible to estimate (depends on % of crops kept in continuous no till)

The future

- Possibly 200 m ha of biotech crops grown by 20 m farmers by 2015 (ISAAA forecast)
- Application of existing traits to wider range of crops
- New traits like drought tolerance
- New quality traits like high omega-3 oil content crops

Concluding comments

- Technology used by 8.5 m farmers on 87 m ha (2005)
- Delivered important economic & environmental benefits
- + $27 billion to farm income since 1996
- -224 m kg pesticides & 15% reduction in env impact associated with pesticide use since 1996
- Carbon dioxide emissions down by 9 billion kg in 2005: equal to 4 m cars off the road for a year

Concluding comments

- GM IR technology: improved profits & env gains from less insecticide use
- GM HT technology: combination of direct benefits (mostly cost reductions) & facilitation of changes in farming systems (no till & use of broad spectrum products) plus major GHG emission gains
- Expect continued wider adoption of technology = improved profitability, improved environment